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Applying Virtual and Augmented Reality to the Teaching of Anatomy



At the Faculty of Health Sciences and Medicine at Bond University, a trio of prominent academics have teamed to develop an exciting project that revolutionises how anatomy will be taught and experienced by students.

Assistant Professors Athanasios Raikos and Christian Moro, and Associate Professor Allan Stirling are using both virtual and augmented reality technologies to dramatically improve the students' understanding of human anatomy. In the following interview Athanasios discusses the application of this technology to teaching anatomy.

Why Virtual Reality?

Athanasios: Virtual reality technologies have been available for some time now, however the processing power of past computers and the quality of the virtual reality devices has been the limiting factor in consumer uptake.

As a general rule, computing power doubles every two years, and the good news is that current computers and graphics cards are now able to handle virtual reality, and developer kits that enable the development of virtual reality applications are now available.

Inevitably, the immersive possibilities of this technology have attracted the attention of educators and the gaming and entertainment industry alike.

Market predictions indicate that in the near future there will be a transformation in the way people play games, watch films, learn, and socialise. The forecast is that augmented and virtual reality could hit US\$150 billion revenue by 2020.

What is the advantage of using a virtual environment?

Accompanying this new technology is a plethora of new questions and concerns from the public, but we believe that if correctly structured, virtual reality environments can greatly supplement the teaching process in medical and science education. Virtual reality provides an incredibly immersive way for students to explore the human body that cannot be done using a textbook or a PowerPoint slide.

What are the goals of this project?

Our initial goal has been to design a multiplatform interactive learning module where students learn anatomy using virtual and augmented reality technologies.

Each teaching module is based on specific learning objectives/outcomes of the curriculum and offers detailed photorealistic graphics of the human body. Modules are accompanied by voice narrations, prepared by our team of academics, which guides the learning experience and provides relevant context.



Left to Right: Associate Professor Allan Stirling, Assistant Professors Christian Moro and Athanasios Raikos using the Oculus Rift development kit.

The team don't believe that this equipment can replace teaching or classroom learning, however it can assist with experiential learning, solidifying new knowledge and providing an added insight into delivered material.

In addition, this teaching technology can also assist with distant learning students in rural environments, universities or hospitals. By tracking a user's head and finger movements, new horizons can be explored and encapsulated in educational material.

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What are some of the Challenges?

Some feel that immersive technologies such as virtual and augmented reality could lead to user isolation.

We have considered these types of potential issues and have decided to stream our research into finding the optimal benefits of these technologies in anatomical education.

There are also the development challenges of learning to use new software, accessing 3D anatomical models and building the virtual environment.

Virtual reality sickness is an added issue, which can be induced by poor frame rate, moving too fast in the virtual reality environment or taking control of the experience away from the participant.

The physiology behind virtual reality sickness is not currently clearly understood, however there is potential for us to contribute to research in this area.



The team illustrate the equipment used for development of the simulation.

What were some of the benefits of this approach?

Textbooks, images, and videos work quite well with basic concepts, but what about when you need to learn something really complex, such as the human body for example?

Our bodies contain an enormous amount of complexity when it comes into understanding the full depth of the human structure. Conceptualising the accurate spatial relationship of anatomical structures such as bones, muscles, neurovascular structures, and connective tissue can be intimidating.

Learning anatomy based on the clinical approach is very helpful as it helps link the concept of structure with clinical applications, however there can be oversight of the topographical and morphological element.

Medical education has many similarities to other careers, such as pilot training, as it requires a lot of simulation exposure before practising on real patients.

You would expect your doctor have spent a serious number of hours using mannequins, carrying out cadaveric dissections, or hands-on surgical workshops ensuring the proper training.

Our mission in medical and allied health sciences education is exactly this. In addition to the theoretical knowledge, we need to expose our students to a large degree of simulation training before their contact with real patients.

Most modern teaching facilities offer a variety of simulation modules ranging from simulating patients for clinical skills learning, virtual scenario-based computer software, to mannequins for practicing basic medical interventions and life-saving skills.

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The problem with many of these simulation modules is that students need to have access to facilities in order to receive the training. Moreover, as with many other things in life, when students don't keep refreshing their skills and knowledge then they lose it.

Virtual reality and augmented reality technologies are amazing exactly for this reason. They can be used practically anywhere once the devices and software have been acquired.

The team's challenge then, is to design the interface and content for the virtual anatomical environments so that they are sophisticated enough to expose the required levels of complexity, and provide a realistic simulation for students.

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How will this impact student learning?

The research team has already acquired virtual reality developer kits, and augmented-reality capable devices. These development platforms are not yet widely available, however commercial versions will be released in 2016. We will be ready when these devices arrive next year, and our eager student participants are already getting excited about the possibilities.

In the near future participants will have the opportunity to learn anatomy through a variety of innovative modes of learning including virtual reality, augmented reality, tablet-based devices, and podcasts. Our research team is confident that these devices, if used correctly, can transform students' learning experience by helping them visualize other perspectives. A major potential innovation of this research would be the identification of optimal application of this technology in learning and teaching.

What next?

The Team is currently working on virtual reality glasses/masks where the environment is fully interactive and the user is completely immersed. We still need to finalise the augmented reality modules so that students can utilise mobile devices to scan QR codes and load specific anatomical models.

In 2016 the research will be expanded to encompass holographic technologies where 3D holograms depicting human models are projected in front of many users at a time.

Having multiple users from distant locations learning together in the same virtual 'room' is expected to transform many industries, and it is our plan for Bond University to be at the forefront of this education.

It is exciting to think that technologies previously seen only in sci-fi movies will soon have real world applications.

"Virtual reality is an entirely unique technology application that creates an immersive user experience."

What feedback have you received from students or your peers?

The software modules have been tested by students and academics and have been very positively received.

Initially, the most common response we receive is 'wow!' as the user discovers the ability to 'walk' into a skull, and explore and interact with its features.

The user is then able to completely explore other areas of the body at their own pace and volition, experiencing the depth of anatomical detail.

A working model was demonstrated at the 2015 Bond Open Day, and the full suite of modules will be available for viewing at the 2016 Bond Open Day.

Everyone is invited to come and experience the virtual reality modules for themselves.

Any final thoughts?

Although the virtual reality devices require state of the art imaging processing capabilities, and surpass the needs of even the most demanding 3D video games and applications, virtual reality is an entirely unique technology application that creates an immersive user experience.

In the near future this technology will become widespread and the potential implications for experiential and self-discovery learning, and society in general are immense. We are excited to be at the forefront of this technology revolution. ■

Athanasios is currently an Assistant Professor of Anatomy at Bond University. He teaches anatomy, histology, and embryology to medical and biomedical students.

Athanasios was born in Greece and worked as a Resident doctor in general surgery. He completed a Medical Degree at Aristotle his Doctorate of Medicine at Ruhr University of Bochum (Germany) and completed a Master of Clinical Education at Bond University.

Athanasios is an investigator of the topographic and surgical anatomy domain. He is also a developer of interactive 3D media for learning anatomy. In addition to this, Athanasios undertakes educational research on virtual and augmented reality technologies and their usefulness in medical and allied health education.



Athanasios testing an anatomy simulation on the Occulus Rift.